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ABSTRACT

To determine whether scientists and science students would accept a simplified writing style, two studies were conducted. In the first study, respondents--1,089 scientists from agricultural experiment stations, 20 station editors, and 59 editors of scientific journals--answered a questionnaire requesting biographical information and reactions to a simplified writing style and a difficult writing style, typical of that found in scientific journals. The subjects were asked these questions: (1) Which style do you prefer? (2) Which style is more appropriate? and, (3) Which author appears more competent? Most of the respondents preferred the simplified style, but many indicated that they had greater respect for the writer of the more complicated passage. In the second study, 196 students completed a briefer form of the same questionnaire; most of them also preferred the simplified style. Some of them perceived their communication teachers as suggesting a less complex style than that suggested by their engineering/science teachers. The majority expected to use simplified style in the future. Techniques for further research on these questions are suggested. In conclusion, the two challenges for technical writing teachers or technical editors are that they should try to convince students and scientists to value a simplified style of technical writing and that they must be sympathetic to factors other than readability that influence readers' evaluations of an author's credibility and esteem. (Tables of findings accompany the text.) (EL)

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TECHNICAL WRITING STYLE: PREFERENCES OF SCIENTISTS, EDITORS, AND STUDENTS

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On at least two occasions in my life, I've experienced what I call a "professional crisis." At those times, I asked myself, "Do I really know what I'm talking about? Is what I'm doing appropriate and worthwhile?"

The first crisis occurred while I was editing a journal manuscript for one of the scientists in the Vermont Agricultural Experiment Station, which is the research branch of the College of Agriculture for which I work. After listening to me say why he should use active verbs, shorter sentences, and personal pronouns, the scientist replied, "That style may be good for popular writing, but my professional journal will never accept it." I was stunned. Was he right? My communication teachers had convinced me of the merits of clarity, brevity, and precision. But might it be possible, I wondered, that scientists would hold different values relative to writing style?

The second crisis occurred while I was tutoring 110 science and engineering students in technical communication at the University of Wales Institute of Science and Technology. Was my teaching on the merits of clarity, brevity, and precision influencing the students' preference for and choice of a style? In other words, did they accept what I had to say as valuable and worth adopting? This paper discusses some of the results from two studies in which I attempted to answer these questions.

Opinions of Scientists and Editors

While suffering my first crisis, I met Dr. John Kirkman, then chair of the communication studies program in the English Department at the University of Wales Institute of Science and Technology. Kirkman has studied the style preferences of engineers and scientists in Great Britain. In one study, he found that British chemical engineers, by a three-to-one margin, preferred a simplified style of writing (characterized by short sentences, active verbs, personal pronouns, concise phrasing, and familiar words) than the more complicated "traditional" style of their journals (Kirkman 1971). However, he found that some scientists who preferred a simpler style were reluctant to use it for fear of losing credibility or esteem in the eyes of their readers.

Ewa Bardell (1978), a graduate student of Kirkman's, identified several variables that seemed to influence judgments of credibility:

- competence in subject matter
- appropriate use of language and style
- communication skills
- intentions toward readers/listeners
- personality
- objectivity
- trustworthiness
- dynamism

The opinions of the nearly 400 academic and industrial scientists in Bardell's study parallel those of the engineers in Kirkman's study. She

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found that 76% of her sample preferred the simpler of two style choices and 54% considered it more appropriate for scientific writing. And she concludes that language and style influence the credibility accorded to scientists by their readers. With Kirkman's and Bardell's blessings, we editors in the Vermont Agricultural Experiment Station decided to replicate Bardell's study with a population of scientists from the United States.

Nature of the Scientist-Editor Study

Three natural audiences for our study were the Experiment Station scientists who write manuscripts for scientific journals, the Station editors who frequently edit these manuscripts before they are sent to journals, and the journal editors who eventually receive these manuscripts. Twelve Experiment Stations in the Northeast agreed to participate in our study. An informal review provided us with a list of 69 journals to which Northeast Station scientists submit manuscripts. Thus, we had a potential audience of 1,645 Station scientists, 24 Station editors, and 69 journal editors.

Our questionnaire was modelled after Bardell's (1978) and consisted of two parts. Part One asked specific "biographic" questions of each audience, plus their opinions about certain aspects of the editorial process. Part Two contained two passages judged to contain the same information, but written in different styles by two fictitious authors--a Mr. Brown and a Mr. Smith. For comparison purposes, we decided to use the same phrasing used by Bardell. Respondents were asked to respond on a three-part scale (Brown, no discernible difference, Smith) to questions about style preferences and the credibility of the authors as reflected by their style.

The two passages supposedly were taken from the middle of similar articles on the hormonal basis of aggression in animals. The Brown passage consisted of one paragraph; sentences averaged 36 words; and it contained three active-verb phrases, nine passive-verb phrases, and 37 prepositions. The Smith passage consisted of three paragraphs; sentences averaged 17 words; and it contained 12 active-verb phrases, four passive-verb phrases, and 21 prepositions.

Word and sentence length generally are good predictors of readability (Klare 1975). The Brown passage, with an average sentence length of 36 words, is categorized as very difficult reading (Flesch 1946; Rathbone 1972; Council of Biology Editors, Committee on Form and Style 1972). On the other hand, the Smith passage, with an average sentence length of 17 words, is of standard difficulty, suitable for a high school-trained audience. Professional writers' sentences average in the low 20's (Houp and Pearsall 1977). While neither passage is at this level, the Smith version is much closer.

We sent the questionnaires directly to the journal editors and Station editors and collected their responses. Coordinators at the 12 Northeast Stations distributed and collected anonymously completed questionnaires at their Stations, and handled a followup mailing two weeks later. To offset the influence of order of presentation, half of the questionnaires were prepared with the Brown passage first and half with the Smith passage first.

For most of the data, we simply counted responses and determined percentages. For selected variables, we formed contingency tables and performed chi square tests to determine the independence of the variables. For significant chi squares, we performed proportion separations (Wales et al. 1979).

Assumptions, Definitions, and Limitations

We assumed that professional communicators (those trained in English, journalism, communication, humanities, and probably not in science) may prefer a different style of technical writing than do scientists. Or if there isn't an actual difference in style preference, there is at least a perceived difference in preference. John Wilson, Jr., writing in Science, describes the "scientific community's" style preference this way:

> Standard, accepted sci-tech gobbledygook is acceptable and expected. It's all that is wanted. Journal editors wouldn't accept, nor would the referees, a paper in plain English. It would be too long. It would not ring true. It wouldn't be bedaubed with the beloved, viscera-satisfying jargon....It would sound--horrors!--like some of the simple-minded pieces in Physics Today or Scientific American (Wilson 1969:986).

The writing style used by many authors who submit manuscripts to scientific journals often is characterized by overuse of jargon, verbosity, obscurity, pretentious diction, illogical arguments, and invalid conclusions (Fuccillo 1977; Boke 1976). Communication specialists, however, advocate clear, concise prose; short sentences; active verbs; personal pronouns; and familiar words (Rathbone 1972; Houp and Pearsall 1977).

For the purposes of this study, the Brown passage is considered an example of "complex" technical style. The Smith passage is considered an example of "simplified" style. "Scientific writing" and "technical writing" are considered synonymous. The results of this study are limited to the surveyed population of Station scientists in the Northeast and of selected journal editors. No effort was made to randomly sample the opinions of those people who chose not to respond to the questionnaire.

Responses to Part One of the Questionnaire

Of the 1,089 Station scientists who responded, 92% were males. Nearly 75% were associate or full professors. Slightly more than a quarter were plant and soil scientists; the next highest groups were animal scientists, microbiologists and biochemists. Nearly 44% had published fewer than one article per year in a refereed journal between 1975 and 1977; about 10% had published more than three articles during that time. Most (67%) rated themselves as above average or excellent writers. However, rank, frequency of publication, and self-evaluation of writing ability did not significantly influence responses to the questionnaire. This seemed to contradict Kirkman's finding that age and job function influenced style preference (1971).

Table 1. What most influenced the writing style of Station scientists?

Item	% rating as very influential or influential
Looking at scientific journals	82.6
Taking English composition courses	67.6
Interacting with thesis advisor	61.0
Doing what seems right	52.6
Taking science classes	42.8
Working with a technical editor	34.7
Taking technical writing course	24.1
Other (includes peer review)	12.8

Table 1 shows what items influenced Station scientists' writing style. Nearly 83% rated what they learned from looking at scientific journals as being very influential or influential. This is particularly important when you consider that the style of writing frequently found in technical journals resembles that of the Brown passage (lengthy, passive voice, jargon). On the other hand, nearly 68% said that they were influenced by what they learned in English composition courses. That only 24.1% mentioned the influence of technical writing courses may simply reflect the fact that until recently many universities and colleges did not offer such courses.

Of the 20 Station editors who responded, half were female. Eight majored in journalism or agricultural journalism, four majored in English, and the others majored in home economics, humanities, graphic design, or biology. Of the 59 journal editors who responded, 52 were male. Thirty-three had majored in engineering or in the natural or physical sciences, 15 in communications or the humanities, and the remainder had joint science-communication or other majors. Nearly 58% held another full-time job.

We asked journal editors what they think of the quality of manuscripts that they receive. We also asked Station scientists how they would rate themselves as writers (Table 2). Only 29% of the journal editors felt that the general level of the manuscripts they receive is "excellent" or "above average." However, 67% of the Station scientists rated themselves as "excellent" or "above average" writers. Although these figures are not directly related, perhaps they indicate that some authors of scientific manuscripts may not write as well as they think they do, or at least that journal editors and Station scientists have different standards for writing quality (Wales and Ashman 1978).

Responses to Part Two of the Questionnaire

I will only focus on three questions that we asked our respondents: which style do you prefer (Brown = complex; Smith = simplified), which style do you feel is more appropriate for scientific writing, and which author

appears more competent as a scientist? Tables 3 and 4 show that the majority of all respondents preferred the Smith (simplified) style. However, the pattern differs when we look at opinions on the competence of the scientists. The largest number of all three groups perceived no discernible differences between the competence of scientists Brown or Smith. But of those Station scientists who saw a difference, more (34% to 26%) found Brown to be more competent. In other words, at least some of the respondents who said they preferred the Smith (simplified) style still held author Brown in greater esteem. This confirmed Bardell's (1978) and Kirkman's (1971) findings.

To our surprise, the order in which the passages were read was highly significant ($p < .001$). Of those Station scientists who read the Brown (complex) passage first, 90% preferred the Smith (simplified) style; 54% who read the simplified Smith passage also preferred the Smith style.

Looked at another way, the data show that 91% of the Station scientists who preferred the Brown style read the Smith passage first. Bardell (1978) suggests that respondents would prefer the passage read second; however, this doesn't hold true for the majority of our respondents who read the Smith passage first. Another reason might be mneme, or the congruence of an

Table 2. Quality of manuscripts received by journals compared with Station scientists' self-evaluation of writing ability.*

Journal editors' rating of general level of manuscripts received	Quality	Station scientists' rating of their ability as writers
14.0%	Excellent	9.0%
15.0	Above average	58.0
32.0	Average	27.0
29.0	Below average	4.0
2.0	Poor	0.5

*Totals do not add up to 100% because not everyone responded.

Table 3. Which style do you prefer for scientific writing?*

Audience	Brown	Smith	No discernible difference	No answer
Station scientists	29%	66%	5%	< 1%
Station editors	0	90	5	5
Journal editors	20	70	5	5

*Percentages are extremely highly significant ($p < .001$).

Table 4. Which style do you consider more appropriate for scientific writing?*

Audience	Brown	Smith	No discernible difference	No answer
Station scientists	32%	55%	12%	1%
Station editors	10	76	10	5
Journal editors	25	59	10	6

*Percentages are extremely highly significant ($p < .001$).

Table 5. Which author appears more competent as a scientist?*

Audience	Brown	Smith	No discernible difference	No answer
Station scientists	34%	26%	39%	1%
Station editors	10	25	60	5
Journal editors	17	31	49	3

*Brown-Smith percentages are very highly significant ($p < .005$).

innovation with a previously favorably evaluated practice (Brandner 1969). In other words, if the Smith style matches a style that they have previously evaluated as good, then they are more likely to evaluate it favorably now.

Another possibility might be that respondents who read the Brown (complex) passage first may have had to struggle to understand what the author was trying to say; this group was highly receptive to the simpler, less complicated Smith style. On the other hand, maybe some of those respondents who read the simplified Smith passage first (and thus perhaps understood more easily what the authors were trying to say than did those who read the Brown passage first) may have been more comfortable with the Brown style because it resembles what they see in their professional journals.

Conclusions to Scientist-editor Study

But this is all speculation. More controlled research needs to be done before a definitive statement can be made about scientists' and journal editors' style preferences and their estimations of scientists' esteem. But even as tentative as these results may be, my worst fears that the style of writing I learned to value differed from that valued by scientists (my first professional crisis) have been quieted a bit. Perhaps scientists just might also prefer a simplified style of writing and consider it more appropriate

for technical writing. However, we technical editors must also keep in mind that factors other than preference and readability (such as evaluations of authors' competency) also affect choice of a style. A challenge to teachers of technical communication is to convince future generations of scientists to value a clear, precise, and less complex style of technical writing.

Opinions of Students

In 1980-81, while a visiting lecturer at the University of Wales Institute of Science and Technology (UWIST), I was confronted with the second of my professional crises. What were the students' opinions about the simplified style of technical writing that I and the other communication instructors were promoting? Did they think that we communication instructors knew what we were talking about?

We decided to survey those engineering and science students at UWIST who are required to take a two-semester technical communication course in the English department. Eighty-five percent were Anglo-Welsh (from Scotland, England, Ireland, or Wales) while 15% were from overseas (Malaysia, Middle East, Africa--usually former British colonies). Of the overseas students, 50% will use English professionally. Ten percent of the students were female.

Nature of the Student Study

At the end of the second semester of the course, we instructors gave the students the same Brown-Smith questionnaire designed by Bardell (1978) and used in the Northeast study (Wales and Ashman 1978). However, we geared the questions specifically to the students. In the absence of a pretest, we asked for the students' perceptions of their opinions about technical writing before they took the course; we also asked which style they think they might use in the future. We used a five-step Likert scale (ranging from "Definitely Brown" to "Definitely Smith"). A second part of the questionnaire required the students to analyze two sentences for readability. One sentence was written in the Brown style and one in the Smith style. These data are still being analyzed and so will not be discussed here.

The questionnaire was administered to all students who attended the last week of classes. Of the 196 who completed the questionnaire, 17 were majoring in mathematics and statistics, 24 in applied biology, 50 in mechanical engineering and engineering production, 77 in engineering and electronics, and 28 in opthalmic optics. All data were coded and computer analyzed. For ease of analysis, the five-step scale was converted to a three-step scale by combining the "definitely" and "probably" categories. The Binomial test was used to test the equality of the proportions selecting Brown and Smith (ignoring no opinion) for each question. To determine the influence of a student's major and which passage was read first, we performed the Kurskal Wallis test ant the two-sided Mann-Whitney test. For selected variables we computed Kendall's tau's to determine the relationships among the variables.

Definitions, Assumptions, and Limitations

As with the scientist-editor study mentioned earlier, we operationally defined the Brown passage as representing complex technical writing and the Smith passage as representing a simplified style. We assumed that the students had some perception of their previous and present writing style and preferences; of their past and current teachers' recommendations for appropriate technical style; and of their possible future use of a style. We also assumed that the students would be as honest as possible in their responses.

We assumed that science teachers could influence students' preference for a technical writing style. Fucillo argues that "science students tend to adopt the ponderous writing style of technical literature," and that their science teachers imitate the style of their peers or even may "have acquired a certain type of technical writing as an obligation of [their] training" (1976). Donnellan and Ross, in their study of scientists' writing productivity, have found that their respondents listed thesis advisors or major professors as most often influencing their writing style (unpublished). We also assumed that English or communication teachers could influence students' preferences, as mentioned earlier (Wales et al. 1979).

Some obvious limitations of our study include the lack of a pretest and control group. Also, we did not match the style of writing students actually use with the style they think they use. And no effort was made to determine the opinions of those students who did not show up for the last week of classes and thus did not complete the questionnaire. Another limitation is that the questionnaire was administered by the students' communication instructors. One cannot help but wonder whether the results might have been different if the questionnaire had been administered by their science or engineering instructors. And sex and ethnic origin were not examined as possible independent variables, which is an unfortunate oversight of this study. Therefore, these results must be looked at only as suggestions for future research.

Student Questionnaire Responses

Table 6 contains the students' choices for style preference, appropriate style, and competence of the scientists "now that [they] have completed the course," plus their assessment of the style that they used before taking the communication course, the style they use now, and the style they intend to use in the future. Clearly, the simplified Smith style is the choice of most of these students.

Of those who made a choice, 22% felt that their engineering or science teachers had a better understanding of appropriate technical style while 57% felt that their communication teachers had a better understanding. When asked which style they thought their engineering/science teachers suggested, 24% said the Brown (complex) style while 50% said the Smith (simplified) style. Conversely, 90% thought their communication teachers suggested the Smith style while only 9% thought they recommended the Brown style. In other words, at least some students perceive their communication teachers as

Table 6. Student responses on style preference, appropriateness, and use, and on the competency of the authors.

Question	Brown	Smith	Not sure, neutral	No answer
Preference*	9%	82%	7%	2%
Appropriate style*	9	84	6	1
Competent scientist*	8	41	48	3
Style use:				
Before taking course+	41	46	10	3
Now*	12	81	6	1
In future*	9	80	10	1

*Extremely highly significant ($p < .0001$). NS = No significant difference.

suggesting a different and less complex style than do their engineering/ science teachers. Regardless of who they think has a better understanding of appropriate style, however, the majority of students see themselves as using the style suggested by their communication teachers (the Smith style) and plan to use this style in the future.

Although 71% of the students who now preferred the Brown style read the Smith passage first, order of presentation did not significantly affect responses because of the small sample size. However, another interesting relationship appeared. All students who think that their engineering/ science teachers recommend the Brown style AND that these teachers have a better understanding of appropriate style, now say that they use the Brown style.

Conclusions to the Student Study

As mentioned earlier, the results of this study must be looked at cautiously. Future studies should include a pretest, control group, and random samples. Perceptions of writing style use should be matched with actual use. Factors other than the course in technical communication must be examined as possible influences on style preference. Also, these first- and second-year students may not have yet been indoctrinated into the values and norms of "the scientific community." Therefore, future studies should also focus on graduate students or working scientists. Until more work is done in this area, my concerns over whether technical communication courses are influencing science and engineering students' values relative to technical writing style (my second professional crisis) still are unresolved.

Challenges for the Future

In closing, let me offer two challenges to those of us who teach technical communication or work as technical editors. First, we should try to convince students and scientists to value a clear, precise, and less complex

style of technical writing in order to improve communication within and outside the scientific community. And second, we must be sensitive to the importance of factors other than readability that influence evaluations of an author's credibility and esteem. If we do this, then possibly we can be more persuasive when urging the use of clarity, brevity, and precision.

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